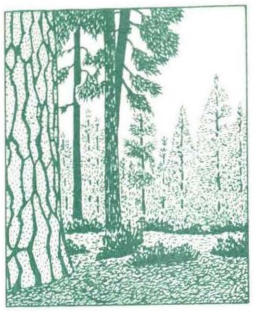
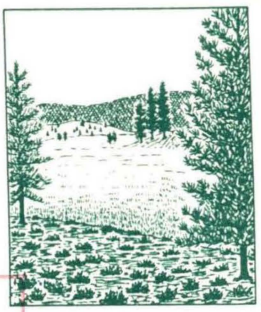


FOREST RESEARCH NOTES

CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
KEITH ARNOLD, DIRECTOR

U.S. DEPARTMENT OF AGICULTURE – FOREST SERVICE



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October 31, 1957

THE HELICOPTER--A NEW MEMBER OF THE HOSE-LAY TEAM

Floyd W. Waklee, Forestry Equipment Engineer,
California Division of Forestry;
Herb Shields, Mechanical Engineer, Arcadia
Equipment Development Center;
Carl C. Wilson, Division of Forest Fire
Research, California Forest and Range
Experiment Station

The helicopter with a new hose-laying accessory proved it could lay fire hose rapidly and safely in 1956.[1/] But after more than a dozen tests and two trials on wild fires, oldtimers still were skeptical about this new hose-laying technique.

They asked, for example, "Is this operation practical in heavy timber? Why isn't it possible for the pilot to start the hose lay rather than depend on a man on the ground? You can lay 1,000 feet of hose in less than a minute but can you beat a hand crew on a long lay? When and where do we use this airborne hose-lay device on fires?"

We have some answers now. They came from recent tests conducted over a 2-mile course by the California State Division of Forestry, the Arcadia Equipment Development Center of the Forest Service, and the California Forest and Range Experiment Station. We found that a helicopter can lay hose over any forest cover type and that the pilot can start the lay at his own convenience. Results from these hose-lay tests have given us enough data so that we can provide some practical guidelines for use of the helicopter. Equipment development needs also were spotlighted.

1/ "Improved Fire Hose Dispensing Tray for Helicopters." Arcadia Equipment Development Center, Arcadia, California. Equipment Development Report No. 44, Nov. 1956.

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BERKELEY

THE 1957 TESTS

How did we go about making these tests? We wanted a test site in an area where forest fire fighters might conceivably have to lay hose on wildfires. We also wanted a course that was long enough to give both manpower and machines a good shakedown.

We found a test course at Sorefinger Point near Weimar, California, which met our specifications (fig. 1). It was 10,819 feet long (slope distance), and slopes varied from 4 percent in the open meadow at the start of the course to 55 percent along the brush-covered ridge above the North Fork of the American River near the end of the course (fig. 2). The starting point was at "A", 1,940 feet, and the lay ended at "C", at 800 feet. The highest point on the course was 2,245 feet at point "D". We divided the 2-mile course into 15 sections on the basis of changes in cover or slope so that we could record hose lay times under varying conditions. These sections varied in length from 296 feet to 2,730 feet (table 1).

Hose Lay by Hand

The next phase of the operation was to make a hose lay by hand with 1-1/2-inch dacron-fill (lightweight) fire hose over the measured course. A specially trained hose-lay crew did the job. This crew consisted of 6 fire-crew foremen from 6 different counties in District III of the California Division of Forestry. Each man in the crew carried 200-300 feet of hose in conventional pack sacks (fig. 3). They started the lay at Point "A" with a total of 1,800 feet of hose, and the only assistance they received was 5 hose deliveries by truck.

Hose Lay by Hand with Helicargo Assist

During the next part of the test a helicopter dropped hose to the 6-man crew. A cargo drop device, which we called a "cartridge," was used for the first time. This device held twelve 100-foot lengths of hose attached (fig. 4). It was placed in the center of the base heliport by a 2-man crew. The helicopter settled over the package like a mother hen over her nest, and the cartridge was connected to the same bomb shackle assembly normally used with the hose-lay tray. After the load was secured, the helicopter flew to the target selected by the ground hose-lay crew and dropped the hose package from tree-top heights--usually 70 to 100 feet above the ground. The crew then retrieved the hose and continued the lay.

Helicopter Hose Lay

We then prepared to make the entire lay by a helicopter with the hose-lay tray. The first problem was that we had only 4 trays. This meant that there would be long delays in making the 2-mile lay unless some way could be found to prepackage the hose ahead of time. After considerable improvising, the following solution was found:

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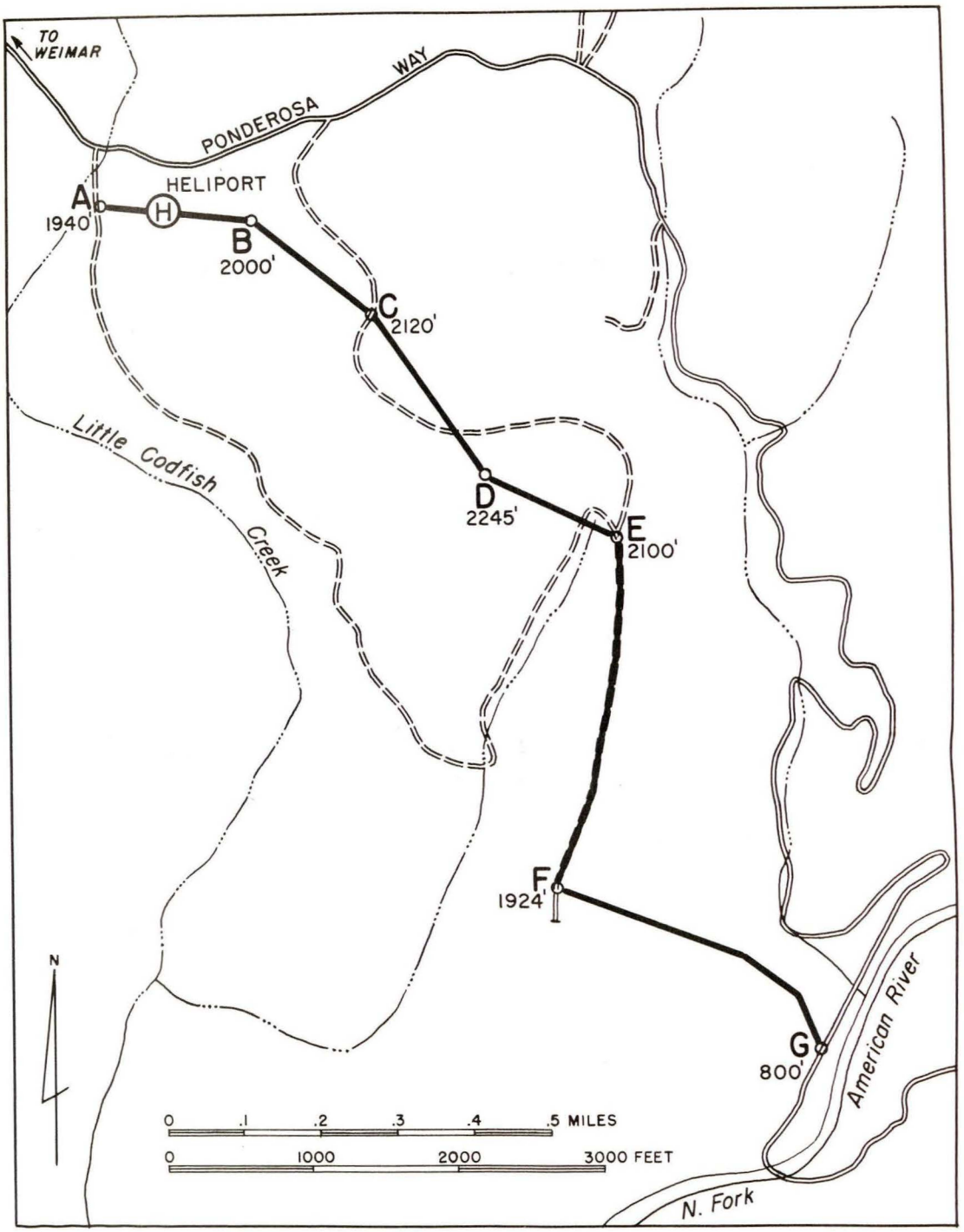

Figure 1.-- Layout of Weimar hose-lay course.

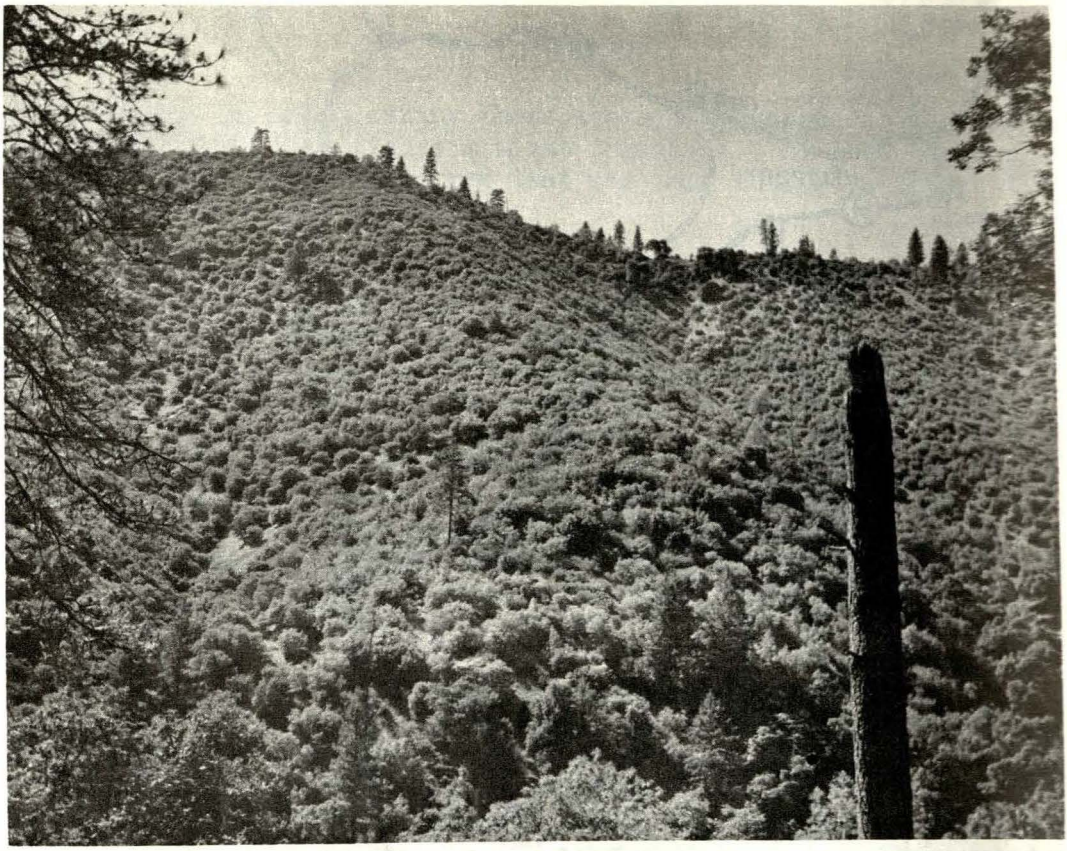

Figure 2.--Steep brush-covered slope between Points "F" and "G" on hose-lay course.

A sheet of plywood was cut to fit the bottom of one of the trays. Three slots were cut in each side of the sheet to serve as guides for tie ropes. The sheet was laid in the helicopter hose tray and the hose was packed in the tray in the conventional horseshoe fashion. When the tray was filled with 800 to 900 feet of hose, 3 bottom ropes were placed under the plywood and brought across the top of the hose and tied firmly. The hose and plywood package were then lifted out of the tray and stockpiled for future use. When it was needed, the package was slid into a tray, and the ropes were untied and removed. The package was pulled forward in the tray about 12 inches. The hose was then shoved back in the tray, and this exposed 12 inches of the plywood. Two men pulled out the tray, and the coiled hose sat in the tray all ready for tying to the perforated bottom. This entire operation took a 7-man crew only 18 minutes. At one time during the operation there were 10 packages of hose stockpiled at the heliport ready for immediate use.

Table 1.--Hose-lay test, California Division of Forestry;

Sorefinger Point, Weimar, California; June 10-13, 1957

Section of course (Stations)	Distance Sect.	Distance Total	Av. slope	Cover Type	HAND LAY BY MEN Time	HAND LAY BY MEN Hose needed	HELICOPTER HOSE LAY Est. Time[1]	HELICOPTER HOSE LAY Est. Hose needed
	Ft.	Ft.	Percent		Min.	Ft.	Min.	Ft.
0 - 1	784	784	+4	Grassy Meadow	4.3	800	10.1	908
1 - 2	486	1270	+6	Mixed Brush	3.7	500	6.3	563
2 - 3	394	1664	+22	Oaks and Bear Clover	3.5	400	5.1	456
3 - 4	601	2265	+3	Oak with Occas. Pine	6.5	600	7.8	696
4 - 5	803	3068	+4	Pine and Oak	5.0	900	10.4	930
5 - 6	392	3460	-7	Open Pine	2.0	400	5.1	454
6 - 7	404	3864	-27	Brush w/Occas. Pine[2]	12.8	400	5.2	468
7 - 8	864	4728	-34	Brush w/Pine Reprod.	9.3	800	11.2	1001
8 - 9	296	5024	+3	Fire Road with Adj. Brush	5.5	300	3.8	343
9 -10	723	5747	-12	Fire Road with Adj. Brush	7.5	700	9.4	838
10-11	392	6139	+16	Fire Road with Adj. Brush and Timber	4.0	400	5.1	454
11-12	700	6839	-23	Fire Road with Adj. Brush and Timber	24.0	700	9.1	811
12-13	512	7351	-6	Fire Road with Adj. Brush and Timber	3.3	500	6.6	593
13-14	738	8089	+19	Fire Road with Adj. Timber	6.7	800	9.5	855
14-15	2730	10,819	-51	Heavy Mixed Brush and Oak[3]	77.0	2700	44.3	3230
					175.1	10,900	[4] 149.0	12,570

1/ Time required to lay hose over each section calculated because it was impossible to have timers at each station during lay.

2/ Hose delivery delayed 4.5 minutes.

3/ Five-minute delay to kill snake; hose delivery delayed 23 minutes.

4/ Includes 4 delays of a total of 42 minutes because pilot could not start lay by himself and had to return to heliport for adjustments.

Figure 3.--Loading two 1-1/2-inch lightweight lengths (about 25 pounds per 100 feet) in conventional pack sack.

The first tray of hose (800 feet) was delivered by the conventional method, that is, by having a man on the ground start the lay by grabbing the dangling hose as the helicopter hovered overhead. But, the timber was so thick it was impossible for the pilot to hover close to the ground, and the other lays had to be started by the pilot (fig. 5). He did this by releasing a 100-foot coil of hose tied to the skid gear so that the 25-pound weight pulled the hose out of the tray. The pilot reported that he felt "jerks" while the hose was paying out of the tray. When we examined the tray, we saw that the couplings were hanging-up on the lip of the tray and causing dents in the smooth sheet at the rear. When we requested the pilot to fly slower than 20 m.p.h., the "hang-ups" decreased. A 4-man crew connected the hose lengths laid by helicopter.

Figure 4.--A 1,200-foot package of 1-1/2-inch fire hose attached to cartridge and ready for installing on adapter assembly of helicopter.

RESULTS

Hose Lay by Hand

We found that a 2-mile hose lay by a small crew isn't the "impossible" job we had visualized. The 6-man crew took only 2 hours and 55 minutes to lay 10,900 feet of 1-1/2-inch hose over the 10,819-foot course. This figure included delays of 4-1/2 minutes while the crew waited for hose deliveries by truck, 5 minutes while killing a rattlesnake encountered enroute, and 23 minutes lost because part of the crew had to walk back uphill to get more hose. Thus, the net time was only about 2 hours and 22 minutes. For the first 4,728 feet, the crew laid hose at an average of about 100 feet per minute. Fatigue began to show at about 47 minutes from the starting point, and the men became increasingly tired as they fought through heavy brush. In spite of fatigue, with a brief rest this 6-man crew would still have been an effective suppression unit even after laying 2 miles of hose.

Figure 5.--Hose lay started by pilot. Hose pays out over tops of oaks and pine trees.

Hand Hose Lay with Helicopter Assist

In a preliminary test the hose package was jettisoned from 60 feet by the pilot, and the hose fell into a clump of brush and rolled across a rock-covered slope. We examined the cartridge and found that it was so badly bent that it had to be repaired before further use. In addition, one length of hose was cut. The remainder of the hose was tested at 350 psi and found OK. Damage to the couplings was negligible.

After dropping 3 loads (3,600 feet of hose) we called the operation off because of excessive hose damage. Several couplings were damaged, and 7 lengths of hose were ruptured or cut by the impact as the 300-pound load and the cartridge hit the ground. In addition, the two men who fitted the hose package on the ship found that there wasn't room to work under the helicopter and the cartridge straps were too short to allow any freedom.

Helicopter Hose Lay

We partially solved the prepackaging of hose for hose-lay trays. Now any amount of hose can be packed on plywood sheets ready for insertion into the helicopter hose tray. We still need better ways to strap the hose package to the plywood and tie the sections to the tray, but these problems can be solved by equipment development.

We found that the helicopter using the hose-lay tray can lay fire hose over gentle to steep topography and above brush and light timber. The key was in finding a way for the pilot to start the lay at his convenience. Total time for the 2-mile lay by air was only 2 hours and 29 minutes, including 42 minutes lost because of mechanical problems. The total time was 26 minutes less than required by the hand crew. And, although 4 men were used to connect the hose when it reached the ground, they said that 2 could have done the job.

We also learned that the helicopter lay takes much more hose over timber and heavy brush. It required 12,570 feet as compared to 10,900 feet for the hand lay--about 16 percent more. This results when the hose laid from the air catches in the tops of trees and droops down between them (fig. 6). We found that the extra 100 feet of hose which was used to start the lay is useful for splicing when the hose sections don't quite come together. This extra length could also be helpful for replacing ruptured lengths in a long lay.

The pilot told us that the lay would have progressed faster and with a wider margin of safety if he had been able to contact the ground crew by radio. Not only can the ground crew be unaware of special hazards visible from the air, but also the pilot may be unable to see ground hazards. Ground-to-air and air-to-ground communications are as vital for helicopter hose lays as for other aircraft operations.

RECOMMENDATIONS

1. We need to develop a way to package the 1,200-foot hose cargo so that it can be jettisoned from a helicopter from 75 to 100 feet above the ground without damaging the hose or couplings.

2. The pilot needs an electrical device to help him release the 100-foot (25-pound) coil of hose which starts the hose lay.

3. We need better ways to strap the prepackaged hose to the plywood transfer pallets.

4. Greater emphasis must be placed on reduced air speed during the hose-lay operation. The pilot should never fly faster than 20 miles per hour and preferably between 10 and 15 miles per hour.

Figure 6.--Hose laid by helicopter droops over 75-foot pines along Weimar test course.

5. Good radio communications between the helicopter pilot and the hose crew on the ground are essential. This is true for all tactical air-support operations on forest fires.

6. Although this test was primarily concerned with laying hose, we recognize the need for delivering pumps and tanks by helicopter at the right place and at the right time. We believe that suitable equipment such as a decelerating mechanism can be developed to do this job.

CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
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